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(19) THE PATENT OFFICE LONDON

(72) Inventors PHILIP SUROWITZ and JOSEPH J. STRING

(54) CRUMPLED LAMINATED FABRICS AND METHODS OF MAKING THE SAME

(71) We, JOHNSON & JOHNSON, a Corporation organised and existing under the laws of New Jersey, United States of America, located at 501 George Street, New Brunswick, State of New Jersey, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to laminated textile fabrics having a high bulk and a soft, crumpled appearance giving three-dimensional surface interest, and to methods of making such fabrics. More particularly, the present invention is concerned with so-called "*nonwoven*" textile fabrics, i.e. fabrics produced directly from textile fibers without the use of conventional spinning, weaving or knitting operations, and to methods of creating unusual three-dimensional effects in such nonwoven textile fabrics.

Although not limited thereto, the invention is of primary importance in connection with nonwoven fabrics formed from card webs of textile fibres, the major proportion of such textile fibers being oriented predominantly in one direction. Typical of such nonwoven fabrics are the so-called "MASSLINN" (trade mark) nonwoven fabrics, some of which are described in greater detail in U. S. Patents 2,705,687 and 2,705,688.

Another aspect of the present invention is its application to nonwoven fabrics wherein the fibers are basically predominantly oriented in one direction but are also reorganized and rearranged in predetermined designs and patterns of fabric openings and fiber bundles. Typical of such nonwoven fabrics are the so-called "KEYBAK" bundled fabrics, some of which may be produced by methods and with apparatus more particularly described in U. S. Patent 2,862,251.

Still another aspect of the present invention is its application to nonwoven fabrics wherein the fibers are disposed at random and are not predominantly oriented in any one direction. Typical of such nonwoven fabrics are the so-called "Isotropic" nonwoven fabrics, some of which may be produced by methods and with apparatus more particularly described in U. S. Patents 2,676,363 and 2,676,364. Other examples of typical nonwoven fabrics wherein the fibers are not predominantly oriented in any one direction are those made by conventional or modified papermaking techniques.

Nonwoven fabrics made by any of the above-described methods and apparatus have become increasingly important in the textile and related industry, primarily because of their low cost of manufacture as compared to the cost of more conventional textile fabrics made by spinning, weaving and knitting operations. Examples of uses for such nonwoven fabrics are wrapping and packaging materials, surgical dressings and bandages, covers or other components of sanitary napkins, hospital caps, dental bibs, eye pads, dress shields, diapers and diaper liners, casket liners, wash cloths, hand and face towels, handkerchiefs, table cloths and napkins, curtains and draperies, quilting or padding, cleaning materials, shoe shine cloths, battery separators, and air or other filters.

Fabric stability and strength are usually

created in such nonwoven fabrics by bonding with adhesive or cementituous materials. The bonding operation employed for stabilizing and strengthening nonwoven fabrics has taken on many forms, one popular form being the intermittent bonding of the nonwoven fabric with a predetermined pattern of spaced, discrete binder areas or lines extending across the width of the nonwoven fabric. The individual fibers passing through these binder areas or lines are adhered into a stable, self-sustaining relationship. The binder areas may also take on any desired shape or form including circles, annuli, ovals, ellipses, triangles, rectangles, squares, diamonds, parallelograms, or other polygons, or combinations of such forms, either regularly or irregularly shaped. The binder lines may extend across the nonwoven fabric at any desired angle to the long axis; the binder lines may be parallel, or they may cross each other to form diamond or irregular polygonic figures; the binder lines may be continuous or discontinuous; or they may be straight, curved, sinuous, or irregularly wavy. Examples of some of these patterns and shapes may be found in the above-mentioned U. S. Patents 2,705,687 and 2,705,688 or in U. S. Patent 2,880,111.

One common factor, however, is to be particularly noted in all of these patterns, namely, that the total surface coverage of the binder areas or lines on the non-woven fabric should not substantially exceed 35% of the total surface of the nonwoven fabric. Preferably, such coverage should be less than 25% and sometimes down to 8% of the total surface of the nonwoven fabric.

Substantially all prior art nonwoven fabrics, regardless of their method of manufacture or of the particular bonding techniques employed, however, have usually suffered from certain inherent disadvantages and weaknesses which have militated against their more widespread acceptance and use by the industry and the ultimate consumer.

For example, due to the nature of the fibrous construction and the orientation and relationship of the individual fibers in such prior art nonwoven fabrics, many of them have been rather thin, flat, two dimensional and drab, and often lacking in fullness, softness and surface interest. This is, of course, objectionable to the industry and to the consumer inasmuch as such fabrics tend to be harsh, papery and deficient in bulk, loft, softness and hand.

It has now been discovered that three-dimensional nonwoven fabrics may be produced having a novel appearance and unique surface interest, along with increased bulk and loft as well as a full and soft hand. Such nonwoven fabrics are not thin, flat or drab and do not have a harsh or papery feel.

According to the present invention, there is provided a method of forming a laminated fabric which comprises adhering a layer of nonwoven fibrous material to at least one surface of a sheet of netting material having intersecting filaments integral at their intersections, said netting material having a potential shrinkage capacity of at least 3% in each direction of intersecting filaments and heating said adherent layers to activate the potential shrinkage capacity to cause said netting material to shrink by said at least 3% in each direction of intersecting filaments whereby portions of the or each layer of fibrous material unadhered to said netting material become crumpled and puckered.

According to the invention, there is also provided a laminated fabric containing at least one layer of a crumpled, puckered nonwoven fibrous material, which fabric comprises a sheet of netting material having intersecting filaments integral at their intersections, and a layer of nonwoven fibrous material adhered to at least one surface of the netting material, the netting material having being shrunk by at least 3% in each direction of intersecting filaments after adherence of the or each layer of nonwoven fibrous material thereto.

In the following description, preferred features of the invention will be described with reference to the accompanying drawings.

In the drawings:

Figure 1 is a simplified schematic perspective exploded view of a laminated textile fabric composed of a plurality of fibrous webs and a centrally located reinforcing reticulate grid netting, prior to assembling and processing in accordance with the present invention;

Figure 2 is a perspective view of a preferred embodiment of the reinforcing reticulate grid netting of Figure 1;

Figure 3 is a simplified schematic drawing of a preferred embodiment of apparatus and a method suitable for use in the present invention;

Figure 4 is a simplified schematic drawing of another preferred embodiment of apparatus and a method suitable for use in the present invention; and

Figure 5 is a simplified schematic drawing of a cross-section of the laminated fabric of the present invention subsequent to processing by the apparatus of Figure 3.

With reference to the drawings and with particular reference to Figure 1 thereof, there is shown a laminated textile fabric 10 comprising an outer layer 12 of fibrous material, a centrally disposed reinforcing reticulate grid netting 14, and another outer layer 18 of fibrous material.

Each outer layer 12 and 18 may comprise merely a single fibrous web or may comprise a number of laminated fibrous webs which are brought together, usually to create a heavier weight layer.

The fibers which are employed to make up the layers 12 and 18 are preferably of a

cellulosic nature, such as cotton or rayon. However, other fibers, either synthetic, man-made, or natural, may be used. Illustrative of such other fibers are the polyamides (nylon 6/6, nylon 6, nylon 610, nylon 11, etc.), acrylic fibers (Acrilan, Creslan, Orlon), modacrylic fibers (Dynel, Verel), polyester fibers (Dacron, Kodel), polyolefinic fibers (polyethylene, polypropylene), cellulose ester fibres (cellulose acetate, cellulose triacetate), or natural fibers such as wool, mohair, or silk. Acrilan, Creslan, Orlon, Dynel, Verel, Dacron, and Kodel are trade marks.

It is not essential that both fibrous layers be composed of the same type of fiber or even that one layer be made of only one type of fiber. Blends and mixtures of the above-mentioned fibers are, of course, possible in substantially any range of proportions, as desired or required.

It is preferred that the fibers be of textile staple length or equivalent length, or at least be cardable, that is to say, they should be from 1/2 inch in average length up to 3 inches or more in average length. Shorter fibers, down to 3/16 inch or less in average length may be added in various proportions to comprise 50% by weight of the web, or even may comprise the entire web, particularly where the original method of web formation involved a fluid deposition of fibres, such as in a conventional or modified papermaking process, or in air deposition techniques. In such fluid deposition processes, average fiber lengths of 3/16 inch or 1/8 inch are preferred to the extremely short fiber lengths of down to 1/16 or 1/32 inch and even below, such as used in papermaking processes for making paper. Such very short fibers, such as these found in conventional paper-making processing, are of use, however, particularly for economic reasons or in those uses and applications wherein the paper-like properties and characteristics of paper and paper-products are not objectionable.

The denier of the synthetic or man-made fibers used in forming the webs is preferably in the range of the approximate thickness of the natural fibers mentioned and consequently deniers in the range of from 1 to 3 are prefered. However, where greater opacity or greater covering power is desired, deniers of down to 3/4 or even 1/2 may be employed. Where desired, deniers of up to 10, 15 or higher, may be used. The minimum and maximum denier are, of course, dictated by the desires or requirements for producing a particular web or nonwoven fabric, and by the machines and methods for producing the same.

The weight of the individual fibrous layer of starting material may be varied within relatively wide limits, depending upon the requirements of the finished product. A single, thin web of fibers, such as produced by a card, may have a weight of from 40 to 200 grains per square yard. The preferred minimum weight of nonwoven fabric layer contemplated by the present invention is, however, 120 grains per square yard, usually obtained by plying three card webs. The preferred maximum weight may range upwards to 3000 or more grains per square yard. Within the more commercial aspects of the present invention, however, fibrous layer weights of from 150 grains per square yard to 2000 grans per square yard are contemplated.

These weights are measured prior to shrinking of the fabric and will increase subsequent to shrinking.

The minimum number of fibrous layers in the starting materials may be one (that is, a fibrous layer to merely one side of the netting). Preferably, however, there should be at least two (that is, one layer on each side of the netting). Three, four, five or more layers, in any desired arrangement may be used where special effects are desired.

A product with a fibrous layer on only one side of the netting will yield a two-sided fabric with different properties, characteristics, and appearance on each side. Such a fabric is of use where such differences can be tolerated.

It is also possible to use sheets or films of various synthetic polymeric materials in combination with the crumpled laminated fabric of the present invention. For example, the centrally disposed reinforcing grid netting 14 may have applied on one side thereof an outer layer 12 of fibrous material and on the other side thereof a composite layer comprising a fibrous layer 18 and a sheet or film of a synthetic plastic polymeric material such as "Mylar" (trade mark) polyester material. Preferably, the fibrous side 18 of the composite layer is the side which is bonded to the centrally disposed reinforcing grid netting 14 and the plastic film is outermost.

Such sheets or films may be relatively impervious or waterproof or, if desired, they may be perforate whereby fluids or other materials may pass therethrough. One specific example of such a perforate sheet or film is described in U. S. Patent 3,307,545. The perforations or openings in the sheet or film may be created by heating means as described in U. S. Patent 3,307,545 or other perforating means, as desired.

The reticulate grid netting 14 which is positioned between the fibrous layers 12 and 18 is preferably a thermoplastic synthetic polymeric material such as polypropylene, polyethylene (low density 0.91—0.94, medium density 0.94, and high density 0.95—0.96 and above); polyamides especially nylon 66 (hexamethylene diamine-adipic acid); nylon 610 (hexamethylene diamine-sebacic acid) and nylon 6 (polycaprolactam); polyesters, especially polyethylene glycol terephthalate, poly-

acrylics or modacrylics; provided they possess the necessary shrinkage properties and characteristics to the required degrees and are capable of activation as described herein.

High density polyethylene having a density generally greater than 0.94 grams per cubic centimeter, as well as predominantly isotactic polypropylene are of exceptional applicability to the present invention.

As shown in Figure 2, the reticulate grid netting 14 comprises intersecting rods or filaments 15 running in one direction and rods or filaments 15a running cross-wise to the rods or filaments 15. The intersecting rods or filaments 15 and 15a are basically integral at their intersections 16 and define a regular pattern comprising a plurality of rectangular open areas 17 therebetween. Methods and apparatus for making such reticulate grid nettings are described in greater detail in Specification Nos. 1,256,406; 1,258,720; and 1,309,419.

The open areas 17 are preferably rectangular or square, as shown, but it is to be appreciated that other geometric shapes may be used. Such other shapes include diamonds, parallelograms, rhomboids, and polygons and are created by having the rods or filaments 15 and 15a intersect at acute or obtuse angles, other than the 90° angle shown.

The length of the sides of these geometric figures may vary relatively widely depending upon the needs and the requirements of the particular situation. Sides as small as 1/8 inch or 3/16 inch are of use, although sides having a length of 1/5 inch to 1/2 inch are more commonly employed. Longer sides of up to 5/8 inch or 3/4 inch are utilizable, and even longer lengths are useful in special situations.

The physical nature and the chemical composition of the grid netting 14, however, must be such that it possesses a sufficient degree of potential residual shrinkage at the time it is inserted between the layers of fibrous materials. Potential shrinkages of only 3% in each direction of intersecting filaments are of use in the application of the present invention but larger potential shrinkages are preferred, e.g. from 5% to 15% in said each direction. Larger potential shrinkages up to 25% or even larger in said each direction are useful in special applications.

The degree of residual or potential shrinkage which exists in the grid netting is controlled to a large extent by the particular processing and manufacturing techniques used in the original formation and pre-treatment of the grid netting itself. This is a very important factor. For example, the greater the degree of elongation, stretching, and drawing of the polymeric material during its original manufacture and the resulting greater degree of molecular orientation created in the polymeric material, then the greater is the tendency of the polymeric material to return or shrink in the direction of its original length. This tendency or "elastic memory" of the oriented, stretched polymeric material to shrink is recognized in the art and such recognition leads to the second factor affecting the shrinkage characteristics of the polymeric material.

The second factor exists in the extent and in the duration of the annealing and relaxing treatment which is used to stabilize or heat-set the grid netting subsequent to its original formation. Use of extensive annealing or other heat-setting treatments such as normally used previously in the art with such products will generally tend to reduce the tendency of the formed grid netting to shrink whereby its shrinkage capability substantially disappears. On the other hand, the use of less extensive annealing of heat stabilizing treatments or the complete ommission thereof will serve to maintain the tendency of the grid netting to shrink after formation whereby it is rendered suitable for the purpose of the present invention.

A third factor in the development of the shrinkage properties lies in the subsequent treatment of the laminated fabric containing the grid netting having the residual or potential shrinkage characteristics. If such a laminated fabric is bonded and is then exposed to a heat treatment, such as a drying or resin-curing treatment at elevated temperatures and the grid netting is maintained in a tensioned condition, then the shrinkage characteristics are usually unable to assert themselves and substantially no shrinkage takes place. However, if the heat treatment takes place under controlled tension conditions, such as the passage of the laminated fabric over heated drying cans which rotate with controlled, predetermined progressively decreasing surface speeds, then the shrinkage characteristics can be asserted and the grid netting will shrink.

The weight of the plastic grid netting may vary relatively widely depending upon the needs and requirements of the particular situation. Weights as low as 15 grains per square yard up to 200 or more grains per square yard are found satisfactory. Within the more commercial aspects of the present invention, however, a range of from 40 grains per square yard to 150 grains per square yard is deemed desirable.

The binder used in adhering the plurality of webs and the grid netting together may be selected from a large group of such binders known to industry. It is necessary, however, that a binder be used which can satisfactorily adhere to and bond the different types of fibers together or at least mechanically interlock the fibers together. Representative of the binders available for such a purpose are: regenerated cellulose; vinyl resins such as plasticized or unplasticized polyvinyl acetate, polyvinyl chloride, polyvinyl alcohol either as homopolymer or copolymers; acrylic resins such as

ethyl acrylate, methyl methacrylate, ethyl acrylate, butyl methacrylate; butadiene resins such as butadiene-acrylonitrile, butadiene-styrene; other synthetic rubbers; natural rubber; urea resins such as urea-formaldehyde, cyclic urea-formaldehyde; aldehyde resins such as melamine-formaldehyde, phenol-formaldehyde, resorcinol-formaldehyde; epoxy resins; celulose derivatives such as carboxymethyl cellulose; hydroxyethyl cellulose; starches; gums; and casein.

These binders may be added, as desired, in the form of emulsions, solutions, dispersions, plastisols or powders Autogenic bonding, preferably by heat and/or pressure and/or solvents, may also be used when thermoplastic fibers are present.

The percent "add-on" of such binder materials to the fabric may be varied within relatively wide limits, depending to a large extent upon the specific binder employed and upon the type, weight and thickness of the nonwoven fabric. For some binders, as low as 1% by weight up to 12% by weight, based on the weight of the dry webs being bonded, has been found satisfactory. For other binders, as high as from 15% to 50% by weight has been found preferable. Within the more commercial aspects of the present invention, however, from 2% to 35% by weight based on the weight of the dry webs being bonded has been found desirable.

The particular size, shape and configuration of the binder pattern used falls within the scope and range of binder areas previously used in the prior art. Examples of some of these binder patterns may be found in the above-mentioned U. S. Patents 2,705,687 and 2,705,688 or in U. S. Patent 2,880,111. Specific examples of binder areas, binder shapes and sizes, and interbinder spaces are noted in said patents.

The individual elements of the apparatus used to carry out the methods of the present invention and to produce the improved laminated crumpled fabrics are relatively conventional. Two examples of such apparatus are shown in the drawings.

In Figure 3, there is shown a preferred embodiment of apparatus suitable for assembling an outer fibrous layer 22, a plastic grind-netting 24, and another outer fibrous layer 28. Pressure-applying rotatable rolls 29, 30 and 31, 32 operate to press the various layers together into a laminated structure 33. This laminated structure 33 is then passed through a conventional adhesive-applying or bonding device 34 wherein the bonding agent is applied. The specific form of bonding device is not critical and basically any well known form of rotatable print rolls which are suitably engraved as to pick up the proper amount of bonding agent from a trough or tank and deposit the same in the desired pattern on the laminated fabric is suitable.

The bonded laminated structure is then forwarded to a suitable heating device 35 which is maintained at an elevated temperature in order to dry and, if necessary, cure the applied binder. As the heat is applied, the binder dries and the grid netting shrinks whereby the fibrous layers pucker and crumple, become more bulky, and obtain a soft three-dimensional crumpled surface effect.

The temperature and duration of time of the heating, drying and curing are, of course, interdependent. Higher temperatures permit the use of shorter exposure times and lower temperatures require the use of longer exposure times. Temperatures in the range of from 212° F. to 295° F. are normally used with exposure times of from 30 seconds to 30 minutes.

The drying takes place under controlled tension whereby the grid netting is permitted to shrink. The use of a series of drying cans rotating with controlled gradually decreasing peripheral surface velocities to counteract the shrinkage of the grid netting is one form of apparatus capable of carrying out such controlled heating and drying operation. The crumpled fabric is then forwarded to a rewind roll (not shown) or is used otherwise, as desired or required.

In the event that it is desired to treat the laminated structure 33 in any special way prior to bonding, such as to rearrange the individual fibers thereof to form a "KEY BAK" bundled fabric, such may be accomplished quite readily by installing suitable apparatus 36, such as described in U. S. Patent 2,862,251, in the production line, as indicated in Figure 3.

The rearrangement of the fibers during such a bundling process is particularly advantageous in that the individual fibers of the fibrous layers are rearranged and moved about sufficiently so that they become mechanically intertwined and wrapped around the individual rods or filaments of the plastic grid netting. Such mechanical adherence of the fibrous layers to the grid netting is particularly advantageous in the case of those polymeric grid materials which are more difficult to adhesively bond to the fibrous layers. The combined mechanical and adhesive bonding thus forms a superior bond to that obtained by adhesive bonding alone.

In Figure 4, there is shown another preferred embodiment of apparatus for assembling the various layers of the laminated structure. In this Figure, the outer layers 42 and 44 are asembled on each side of the thermoplastic grid netting 48. In this particular embodiment, the binding technique is different and the grid netting alone is coated with an adhesive or bonding agent 49 which is contained in a bath 50. As shown, the grid netting 48 is carried over a rotatable guide roll 51 and is carried into the bath 50 containing

the adhesive 49. The grid netting passes under rotatable applicator immersion rolls 52 and 53 and is then passed upwardly between rotatble pressure rolls 54 and 55 and is then forwarded to be inserted between the outer layers 42 and 44.

Again, it is to be observed that the particular form of binder or adhesive application is not critical and substantially any known conventional device may be used to apply the adhesive or binder.

Adjustable rotatable pressure rolls 56 and 57 are employed to press the outer layers 42 and 44 against the grid netting 48. The laminated structure 58 is then passed through a heating device such as a series of rotatable drying cans or a heated oven 60 which is maintained at a suitable elevated temperature as to dry and, if necessary, cure the bonding agent or adhesive and to simultaneously cause the grid netting 48 to shrink whereby the layers pucker and crumple in those areas where they are not adhered to the grid netting 48. As a result, the laminated fabric becomes more bulky and possesses a soft crumpled three-dimensional effect.

Again, it is to be observed that the heating and drying take place under controlled conditions under which the shrinkage characteristics of the grid netting are permitted to be asserted.

Figure 5 represents a simplified schematic drawing of a cross-section of the laminated fabric subsequent to processing by the apparatus of Figure 3 or Figure 4. It is to be noted that the plastic grid netting 64 is relatively flat and substantially planar whereas the fibrous webs 62 and 68 which are adhered to it are puckered and crumpled in the areas 63. Located between these puckered and crumpled areas 63 are those areas 65 wherein the fibrous layers 62 and 68 are adhered to the plastic grid netting 64.

The following Examples of the invention are given by way of illustration.

EXAMPLE I

The apparatus illustrated in Figure 3 of the drawings was used. The plastic grid netting was predominantly isotactic polypropylene; it had a width of 50 inches and weighed 75 grains per square yard. It possessed shrinkage characteristics in both the warp and in the filling direction; there were two filaments per inch in the warp direction and four filaments per inch in the filling direction. Fibrous webs were applied to each side of the plastic grid netting, these fibrous webs were carded rayon webs and each fibrous web weighed 270 grains per square yard.

The laminate was then passed through rotatable drum fluid-rearranging apparatus such as described in Figures 7—8 of U. S. Patent 2,862,251 whereby fabric openings and fiber bundles were formed in the fibrous webs and the individual fibers became mechanically intertwined and wrapped around the filaments of the plastic grid netting.

The laminate was then bonded with an intermittently-spaced wavy line pattern of four lines per inch of a butadiene-styrene copolymer as the bonding agent in an amount equal to 90 grains per square yard. The laminate was then dried on rotatable heated drying cans at an elevated temperature of about 275° F. under controlled tension and surface speed conditions, whereupon the grid netting simultaneously shrunk and caused the fibrous webs to crumple and pucker about 3% in the warp direction and about 6% in the filling direction to increase the bulk of the laminated fabric and to produce a three-dimensional surface interest effect.

The resulting crumpled fabric was soft, had good absorbency and possessed utility as a towel and as a wiping cloth.

EXAMPLE II

The procedures of Example I were followed substantially as set forth therein with the exception that the three layered laminate was passed through a rotatable drum fluid-rearranging apparatus wherein only selected areas of the laminate were exposed to the fluid rearranging into fabric openings and fiber bundles. A more detailed description of such selective rearranging techniques is to be found in U. S. Patent 3,056,406 which describes processes wherein some portions of the rotatable rearranging drum are perforated and are effective to provide for fluid rearranging and other portions of the rotatable rearranging drum are not perforated and do not provide for any fluid rearranging. In this Example, the fluid rearranging took place in parallel strips which were approximately 5/16 inch in width and which extended lengthwise in the long direction of the nonwoven fabric. These parallel strips in which there was fluid rearranging were separated by parallel lengthwise strips in which there was no fluid rearranging. These latter strips were approximately 5/8 inch in width and also extended lengthwise in the long direction of the nonwoven fabric.

In the lengthwise strips wherein there was fluid rearranging, the fibers of the fibrous web were intertwined and wrapped around the filaments of the plastic grid netting and around each other and thus created considerable mechanical gripping between the three layers. In the lengthwise strips wherein there was no fluid rearranging, the fibers of the fibrous web were not intertwined and wrapped around the filaments of the plastic grid netting or around each other to any substantial degree. As a result, there was no substantial mechanical gripping between the three layers of the laminate.

Subsequent bonding, however, did pro-

vide sufficient adhesive gripping to both lengthwise strip areas of the laminate but it was still noted that the adhesion in the rearranged areas was far superior to the adhesion in the non-arranged areas.

EXAMPLE III

The procedures of Example I were followed substantially as set forth therein except that the plastic grid netting weighed 70 grains per square yard. The count was 2×5, that is, two filaments per inch in the warp direction and five filaments per inch in the filling direction The shrinkage characteristics after five minutes at 275° F. were 4% in the warp direction and 6% in the filling direction. The results were comparable.

EXAMPLE IV

The procedures of Example I were followed substantially as set forth therein with the exception that the plastic grid netting was high density polyethylene having a density of about 0.95 grams per cubic centimeter. The results were comparable. The shrinkage in the warp direction was about 4% and the shrinkage in the filling direction was about 8%. Such shrinkages were noted after exposing a laminated fabric under controlled tension conditions to a temperature of about 275° F. for a period of 30 seconds. The resulting crumpled fabric had good absorbency and possessed utility as a towel and as a wiping cloth.

EXAMPLE V

The procedures of Example I were followed substantially as set forth therein with the exception that the apparatus illustrated in Figure 4 was used. The outer layers, however, were both 10 pound basis weight tissue paper. The plastic grid netting had applied to it 30 grains per square yard of the bonding agent. The laminated fabric was passed under controlled tension conditions through a heated oven at a temperature of about 275° F. Shrinkage of about 4% took place in the warp direction, and about 8% in the filling direction and the resulting crumpled paper fabric had good absorbency and possessed utility as a towel and as a wiping cloth.

EXAMPLE VI

The procedures of Example V were followed substantially as set forth therein except that crepe tissue was used having a 20 pound basis weight. The results were comparable.

EXAMPLE VII

The apparatus of Figure 4 was used to form a crumpled laminated fabric from a 2×4 plastic grid netting weighing 45 grains per square yard and two prebonded nonwoven fabrics derived from carded rayon each weighing 200 grains per square yard. The bonding agent was a butadiene-styrene copolymer and was applied in an amount weighing about 25 grains per square yard. The heated oven was maintained at a temperature of about 275° F. Shrinkage of about 4% took place in the warp direction and about 8% in the filling direction. The crumpled laminated fabric had good absorbency and could be used as a wiping material or as a disposable textile garment.

EXAMPLE VIII

The procedures of Example I were followed substantially as set forth therein with the exception that the plastic grid netting had four filaments per inch in the warp direction and four filaments per inch in the filling direction. During its original formation, the grid netting was given an increased amount of stretching and elongation and was then given very little heat stabilizing or heat setting treatments. As a result, the shrinkage of the laminated fabric when exposed under controlled tension conditions to a temperature of 275° F. for a period of 30 seconds was 16% in the warp direction and 18% in the filling direction. The laminated fabric was extremely puckered and crumpled and possessed extremely high bulk.

WHAT WE CLAIM IS:—

1. A method of forming a laminated fabric which comprises adhering a layer of non-woven fibrous material to at least one surface of a sheet of netting material having intersecting filaments integral at their intersections, said netting material having a potential shrinkage capacity of at least 3% in each direction of intersecting filaments and heating said adherent layers to activate the potential shrinkage capacity to cause said netting material to shrink by said at least 3% in each direction of intersecting filaments whereby portions of the or each layer of fibrous material unadhered to said netting material become crumpled and puckered.

2. A method according to claim 1 wherein the said potential shrinkage capacity in each direction of intersecting filaments is from 3 to 25%.

3. A method according to claim 1 or 2 wherein the or each layer of non-woven fibrous material has a weight of at least 120 grains per square yard.

4. A method according to any of claims 1 to 3 wherein the heating of the adherent layers is effected whilst holding the netting material under controlled tension conditions.

5. A method according to any of claims 1 to 4 which additionally comprises placing a layer of non-woven fibrous material on the at least one surface of the sheet of netting material, and rearranging the fibrous material to provide openings and fibre bundles with the individual fibres mechanically intertwined and wrapped around the filaments of the net-

ting material, prior to said layers being adhered together.

6. A method according to any of claims 1 to 5 which comprises adhering a layer of non-woven fibrous material to both major surfaces of the sheet of netting material.

7. A method of forming a laminated fabric according to claim 1 substantially as herein described in any of the Examples and/or with reference to Figure 3 or 4 of the accompanying drawings.

8. A laminated fabric when formed by the method of claims 1 to 7.

9. A laminated fabric containing at least one layer of a crumpled, puckered non-woven fibrous material, which fabric comprises a sheet of metting material having intersecting filaments integral at their intersections, and a layer of non-woven fibrous material adhered to at least one surface of the netting material, the netting material having being shrunk by at least 3% in each direction of intersecting filaments after adherence of the or each layer of non-woven fibrous material thereto.

10. A laminated fabric according to claim 9 wherein the netting material has been shrunk by from 3 to 25% in each direction of intersecting filaments.

11. A laminated material according to claim 9 substantially as herein described in any of the Examples and/or with reference to Figure 5 of the accompanying drawings.

For the Applicants,
CARPMAELS & RANSFORD,
Chartered Patent Agents,
24 Southampton Buildings, Chancery Lane,
London, WC2A 1AZ.

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1331817 COMPLETE SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

Fig.1.

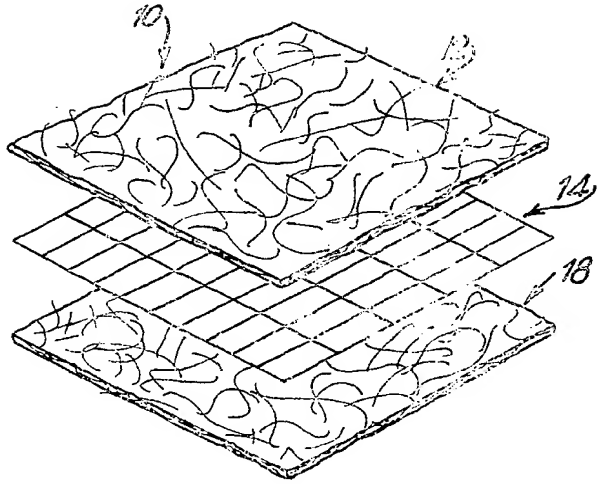

Fig.2.

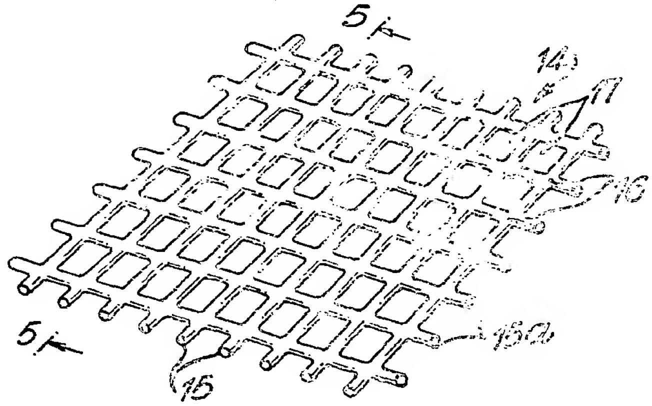

Fig.3.

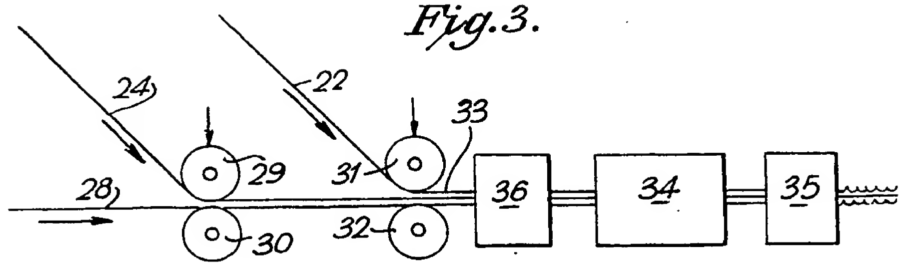

Fig.4.

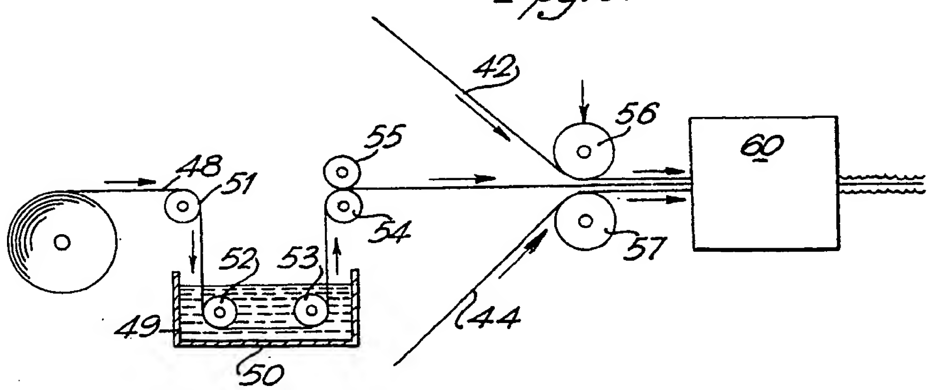

Fig.5.